# GEIA – Enhancing Communications on Global Emissions 2009

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## ABSTRACT

**GEIA (Global Emissions Inventory Activity),** an integrating project of the AIMES (Analysis, Integration and Modeling of the Earth System) project of the International Geosphere Biosphere Program (IGBP) brings together people, analyses, data, and tools to:

- Quantify the anthropogenic emissions and natural exchanges of trace gases and aerosols that drive earth system changes **and**
- Facilitate use of this information by the research, assessment and policy communities.

This presentation provides an overview of some of the latest global emission efforts and discusses how to make this information more readily available. Highlights include:

- **Data bases**: data currently accessible through the GEIA portal; new information on IPCC emissions, past and future, being developed; and other international efforts on emissions
- **Reviews:** upcoming updated overviews of state-of-the-science for man-made and natural sources
- **Catalogues:** planned creation of a data base of papers and reports publicly available concerning emissions
- **New studies:** improved understanding of biogenic emissions
- **Assessments:** strategies to better integrate data from multiple countries
- **Wiki system:** initiation of wiki-based system for emission information exchange

## INTRODUCTION

**GEIA (Global Emissions Inventory Activity)** brings together people, analyses, data, and tools to:

- Quantify the anthropogenic emissions and natural exchanges of trace gases and aerosols that drive earth system changes **and**
- Facilitate use of this information by the research, assessment and policy communities.

GEIA is an integrating project of the AIMES (Analysis, Integration and Modeling of the Earth System, http://www.aimes.ucar.edu/) project of the International Geosphere Biosphere (IGBP) program (http://www.igbp.net/), and over the past 4 years has established strong links with the Atmospheric Composition Change: A European Network (ACCENT, http://www.accent-network.org) that coordinates the European activities on atmospheric composition change.

GEIA is currently chaired by Claire Granier (LATMOS/ IPSL, France and CSD/ERSL/NOAA, USA) and Alex Guenther (NCAR, USA). The members of the GEIA steering committee are:

- Hajime Akimoto (JAMSTEC, Japan)
- Klaus Butterbach-Bahl (IMK-IFU, Germany)
- Frank Dentener (Joint Research Center, Italy)
- Laurens Ganzeveld (University of Wageningen, The Netherlands)
- Ivar Isaksen (University of Oslo, Norway)
- Zbigniew Klimont (IIASA, Austria)
- Jean-François Lamarque (CSD/ERSL/NOAA and NCAR, USA)
- Catherine Liousse (Laboratoire d'Aérologie, France)
- Aude Mieville (LATMOS/ IPSL, France)
- Paulette Middleton (Panorama Pathways, USA)
- Jos Olivier (MNP, The Netherlands)
- Claire Reeves (University of East Anglia, UK)
- John VanAardenne (Joint Research Center, Italy)
- Vigdis Vestreng (Norwegian Pollution Control Authority, Norway)

The GEIA Center (http://www.geiacenter.org), directed by Paulette Middleton, is responsible for the GEIA web site and the GEIA network that currently includes over 800 people around the globe. Many GEIA data base management and workshop organization activities are supported by ACCENT: for over a decade the GEIA Center has been funded by U.S. NSF and NASA.

Recent **GEIA activities** in support of improving emissions data and enhancing use of these include:

1. Further development of the GEIA/ACCENT emissions web portal,
2. Development of ECCAD database of driving variables,
3. Intercomparison of biomass burning emissions,
4. Participation in workshops dealing with climate change and air quality,
5. Participation to the ACCENT global change synthesis documents, and
6. GEIA web site updates and communication with GEIA network.

**GEIA 2009 plans** are aimed at furthering data base development, harmonization of information for assessments, and enhanced communication of information among researchers, analysts, and policy makers. Key steps include the following:

1. Upgrade/update the GEIA/ACCENT web portal, ECCAD data bases, GEIAcenter.org and the GEIA network, and develop plans for long range funding of GEIA operations,
2. Collaborate with the distribution of the emissions used in the IPCC and associated activities, and other international projects and regularly report on these efforts through the GEIA network,
3. Prepare outreach materials highlighting key up to date information on emissions for participation in IGBP and other GEIA related workshops and conferences, and plan for the next open GEIA conference in the fall of 2009,
4. Initiate biogenic emissions research activities -- collaborations involving GEIA, ILEAPS (http://www.ileaps.org/ and IGAC (http://www.igac.noaa.gov/meetings.php) and participate in the the iLEAPS Open Science Meeting in August 2009,
5. Identify and summarize available regional emission inventory assessments on data harmonization and completeness,
6. Start the development of a wiki-based system including a system for emissions information exchange,
7. Create, with the help of the GEIA network, a data base of papers and reports publicly available concerning emissions and keep these updated on the GEIA web site, and
8. Initiate the development of updated GEIA emissions reviews with the help of leaders in each emission category and explore journal publication opportunities as well as web posting.

These highlights and plans are discussed in following sections. Highest priority challenges for the global community and long-term strategies, along with invitations to the community for collaboration on these, are summarized at the end of the paper.

## GEIA ACTIVITIES

### 1. Development of the GEIA/ACCENT data portal

The GEIA/ACCENT data portal, in operation since summer 2005, provides all data under the same format, either ASCII or NetCDF. The portal can be accessed through the GEIA web site (http://www.geiacenter.org), the ACCENT website (http://www.accent-network.org), or directly through the portal website: http://www.aero.jussieu.fr/projet/ACCENT/database.php. Aude Mieville developed the GEIA-ACCENT web portal emissions and graphical tools, through a grant from the ACCENT network.

### 2. Database of driving variables

A database giving access to the data used in parameterizations of anthropogenic and natural emissions has been developed. It currently includes data on population, ecosystems, fire pixels, land-use change, etc. The database has been tested and can be accessed through the site http://ether.ipsl.jussieu.fr and going to ECCAD: emissions data and ancillary data for emissions calculation.

### 3. Intercomparison of biomass burning emissions

Biomass burning emissions are driving the interannual and seasonal variations of several atmospheric compounds such as carbon monoxide and aerosols. An intercomparison exercise is under way within GEIA and ACCENT to better characterize the spatial and temporal variations of these emissions. The exercise is called INTERMEDE-BBSO (INTERcomparison of MEthods to DErive global Burned Biomass from Satellite Observations). Work should be finalized in 2009. Key contact is Cathy Liousse (catherine.liousse@aero.obs-mip.fr).

### 4. Organization workshops on atmospheric composition change

GEIA participated in the organization of a series of international ACCENT workshops, as part as the so-called Barnsdale expert workshops: the goals of these workshops are to identify and review key issues related to atmospheric composition changes. Reports of these workshops are available from http://www.accent-network.org/portal/publications/accent-series-reports.

### 5. Participation in the ACCENT synthesis

Several members if the GEIA community participated in the writing of the ACCENT synthesis discussing the main advances in air composition change issues over the past 5-10 years. This synthesis has been submitted, February 2009, for publication in Atmospheric Environment. Emissions information included in this synthesis could provide a useful contribution to specific in depth reviews of emissions by sectors and/or chemical groupings.

### 6. GEIA web site updates and communication with GEIA network

In addition to the workshops and other GEIA-related meetings throughout the year and initiation of projects to enhance data development, GEIA strives to grow a strong international network and keep these colleagues informed of developments in emissions. This communication and outreach effort continues to take place formally through the GEIA web site and email communications with the growing GEIA network. Interested parties are encouraged to visit (http://www.geiacenter.org), join the network and/or submit interests via the questionnaire.

## GEIA PLANS

GEIA's immediate and long-term plans follow the overarching goals of advancing the science of emissions and communicating highest quality information to the research, assessments, and policy communities.

### 1. Upgrade/Update GEIA Information

GEIA multifaceted communication channels and information products are the core of GEIA operations. To keep these most meaningful to GEIA's communities, it is important to continually upgrade/update the GEIA/ACCENT web portal, ECCAD data bases, GEIAcenter.org and the GEIA network; re-evaluate multi-year plans for enhancing value of GEIA to the science, assessment and policy communities; and actively seek continued, growing collaboration and funding for GEIA operations.

## 2. Contribute to International Assessments

GEIA scientists continue to actively collaborate on international assessments. For example, several are involved with the development and distribution of the emissions used in the IPCC and associated activities, and other international projects and regularly report on these efforts through the GEIA network. This effort involves defining the emissions of chemical species that will be used in the IPCC simulations. This dataset is based on the harmonization of currently available regional and global emissions inventories. Papers discussing the harmonization and the resulting dataset are scheduled for completion in 2009. GEIA is also involved with other international projects such as HTAP and AC&C (Atmospheric Chemistry and Climate; joint project of IGAC-IGBP and SPARC-WCRP).

## 3. Promote Advances in Global Emissions

Developing interesting materials and designing and/or contributing to conferences help advance work on global emissions. GEIA will hold its next open conference this Fall 2009. This conference is anticipated to consider these along with other topics: harmonization and related gridding to address global to local assessments; treatment of fire emissions; natural emissions and land use; and long term change in emissions. The last GEIA conference and formal steering committee meeting was held in Paris in December 2006. Since that meeting, GEIA has been represented at a number of conferences and IGBP program planning meetings, including the IGAC conference in September 2008. GEIA also will be participating in IGBP-related meetings, such as the ILEAPS meeting in August 2009.

## 4. Develop Collaborative Research Programs

In collaboration with IGBP-iLEAPS, GEIA has initiated two activities focused on biogenic emissions. An activity led by Alex Guenther (USA) and Almut Arneth (Sweden) is conducting an intercomparison of biogenic emission models and their driving variables. Initial results have been produced and a publication is expected to be submitted later this year. An activity led by Alex Guenther (USA), Laurens Ganzeveld (Netherlands) and Michael Boy (Finland) is developing 1D models and other tools for investigating canopy scale biogenic emissions and using these models to design field studies and interpret observations. This includes the establishment of a global network of long-term BVOC emission measurement sites (at existing carbon and water flux sites) and a network of sites conducting long-term measurements of biogenic emission, chemistry, turbulence, ecology and hydrology.

## 5. Contribute to Understanding Completeness and Compatibility of Data Bases

Paulette Middleton is working with the Commission on Environmental Cooperation on assessing compatibility of inventories in North America and examining how well the inventories support air quality management of high priority issues, multi-pollutant strategies, and deliberations about the connections between climate change and air quality. These efforts along with others help provide a better indication of how county and regional data bases can be enhanced and harmonized for used in regional and global studies.

## 6. Enhance dialogues among researchers and data users

As strongly suggest by the students at the 2007 GEIA/ACCENT summer school, GEIA will be initiating the development of a wiki-based system for helping exchanges on emissions related work.

### 7. Enhance availability of emissions information

There is a vast amount of information on the development and use of global emissions data. To help make this more readily available, GEiA has already created a catalogue of groups working in these areas. GEIA will expand the catalogue to include publically available papers and reports concerning emissions. As a first step, a short, easy to answer, form is being prepared; the form, to be distributed to the GEIA network, will ask for links to key information and papers on emissions.

### 8. Contribute to the documentation of state-of-science on emissions

In 2002, GEIA coordinated the development of emission reviews. In the next round of reviews, GEIA will be structuring the reports around sectors and/or groups of chemicals. Members of the GEIA network will be invited to participate in leading and/or contributing to the reviews. Publication in journals, as well as direct posting on the web site, is planned.

## HARMONIZING INFORMATION

Harmonizing emission information across temporal and spatial scales is the key challenge to developing consistent trends and projections for assessments at the local, regional and global levels. Approaches to harmonization for global assessments are exemplified by the ongoing efforts to create emission datasets that will be used in the AR5 (Assessment Report #5) of the IPCC (Intergovernmental Panel on Climate Change) report under preparation. These emissions will be used as boundary conditions for the air quality simulations from 1850 to about 2030, as well as to calculate the concentrations which will be used in the coupled earth-system models used in the climate simulations done over the 1850-2300 period..

Emissions of gaseous and particulate species (i.e. aerosols, aerosol precursors, ozone precursors and ozone-destroying agents) from anthropogenic activities and biomass burning have been defined over the full period, using the 2000 dataset for harmonization of the past and current 1850-2000 emissions with the future emissions determined by the Integrated Assessment Models (IAMs). This effort is being conducted by an international team, including several GEIA leaders (i.e., Granier, Lamarque, Liousse, Mieville, and Van Aardenne). Detailed documentation of the effort and data bases will be available later in 2009; a general outline of the approach is provided here.

Historical emissions were created using a variety of existing datasets. In order to perform an evaluation and harmonization across different emission datasets and different periods, the group agreed on evaluating and providing the emissions for 13 sectors: shipping, aviation, land transport, energy, solvents, waste, industrial processes, residential, agriculture waste burning, animals, savanna burning, deforestation, and natural emissions. For each compound considered in this study, comparisons between available inventories have been performed. Based on this evaluation, one dataset was selected for each emission sector for each compound. These different datasets were then harmonized over different regions, in order to ensure a good consistency of the datasets over the full period.

Considerable attention has been given to creating the most up-to-date 2000 emissions (combination of a variety of inventories) as an anchor point between past and future emissions. For the definition of anthropogenic base year emissions, regional inventories were used when available, i.e. for the United States, Europe and Asia. A gridding methodology was also defined, and emissions at a 0.5x0.5 resolution will be provided. Emissions of

biomass burning are based on inventories defined for the recent years using satellite observations of burned areas and active fires as well as statistical data. Historical reconstruction of burned area distributions were used to evaluate past emissions, and a good consistency between past and current emissions was obtained.

Future emissions are generated by integrated assessment models. These projections are calibrated to the consensus year 2000 inventory and are consistent with the four underlying 21st century "representative concentration pathways" (RCPs) and their associated economic, energy, and land-use changes.

It is expected that many modeling groups involved in the IPCC simulations will use earth-system models including interactive models for the calculation of biogenic and soils emissions. However, natural emissions from a few of these models will also be included in the final data sets, so that the biogenic and soil emissions can be used directly in chemistry-transport models.

## CHALLENGES and OPPORTUNITIES

In addition to the overarching challenge of harmonizing data from multiple sources and countries, other challenges to use of emission inventories assessments dealing with chemical changes in the atmosphere from local to global scales remain. Among these are the following:

- Speciation of VOCs into necessary level of detail to properly deal with chemical reactions and adequate address toxic effects of individual compounds
- Speciation of PM emissions by size and composition (and more specifically BC) to assess human health, visibility, and climate impacts
- Application of one country's set of emission factors in other countries and the use of observational data to determine the validity of these applications
- Characterization of unregulated, but important emerging source categories, in particular the shipping industry
- Characterization of biogenic and other natural sources
- Projections of emission changes under diverse regulatory environments across countries
- Projections of emission changes under the influence of changes in climate, land use and energy resources and use

Progress in these and other key areas continue to be central to GEIA's work. Researchers, analysts, and policy maker are invited to join the ongoing information exchanges by joining the GEIA network.

## KEY WORDS
Global, International, Inventories, Assessments